Stress transfer and Quaternary faulting in the northern Alpine foreland

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Within the SPP *Mountain Building Processes in Four Dimensions* (MB-4D) we studied postglacial and present seismic rupturing in the northern Alpine Foreland to better understand the impact and forces of mountain building. We started a seismological field experiment to densify the permanent monitoring networks and the AlpArray Seismic Network. The later was also supported as well as its predecessor UNIBRA (Hetényi et al., 2018; Schlömer et al., 2022). Our StressTransfer network consisted of five recording stations in the Upper Rhine Graben, five in the Molasse Basin and five around the Albstadt Shear Zone (Mader et al., 2021a). The latter are still operating due to the increased seismicity during the last years below the western Swabian Alb. We determined local minimum 1-D seismic velocity models to relocate known events in the study regions (Mader et al., 2021b). Waveform cross-correlation was done to detect hitherto unknown events and recover earthquake sequences around the Albstadt Shear Zone (Mader et al., subm.). To determine fault planes and rupture mechanisms we used relative event locations (hypoDD) and FOCMEC for fault plane solutions.

For the Albstadt Shear Zone (ASZ), an NNE–SSW striking left-lateral strike-slip rupture zone, we determined a direction of the maximum horizontal stress (*SHmax*) of 140°–149°. Down to ca. 7–8 km depth, *SHmax* is bigger than *SV* (vertical stress); below this depth, *SV* is the main stress component. Beneath the shallow Hohenzollerngraben (ca. 2-3 km depth), which is nearly perpendicular to the ASZ, we found an NW-SE striking dextral strike-slip fault zone with very weak micro-seismicity in 11-15 km depth (Figure 1). This zone is possibly a reactivated old upper-crustal tectonic structure. At the interception of the ASZ and the NW-SE striking fault zone we observe NNW-SSE striking sinistral strike-slip and normal faulting micro-earthquakes which belong to a heterogeneous deformation zone with complex faulting. In Figure 1 we summarize our current model for the ASZ and its surroundings. The detection of many micro-earthquakes and the related active faults was only possible with the help of the additional temporal recording stations in the region and the studies of a PhD student (S.M.).

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Hetényi G. et al. (incl. Ritter, J.), 2018. The AlpArray Seismic Network: a large-scale European experiment to image the Alpine orogen. Surv. Geophys., 39, 1009-1033.

Mader S., Ritter J.R.R., 2021a. The StressTransfer Seismic Network- An Experiment to Monitor Seismically Active Fault Zones in the North-ern Alpine Foreland of Southwestern Germany. Seismological Research Letters 92(3), 1773–1787.

Mader S., Ritter J.R.R., Reicherter K., AlpArray Working Group, 2021b. Seismicity and seismotectonics of the Albstadt Shear Zone in the northern Alpine foreland. Solid Earth 12(6), 1389–1409.

Mader, S.M., Ritter, J.R.R., Brüstle, A., AlpArray Working Group, 2023. Fault imaging using earthquake sequences: A new model for rupture processes at the Albstadt Shear Zone, Southwest Germany. J. Seism., subm.

Schlömer, A. et al. (incl. Ritter, J.), 2022. UNIBRA/DSEBRA: the German seismological broadband array and its contribution to AlpArray – deployment and performance. Seis. Res. Lett., 92, 1773–1787.

Stange S., Brüstle W., 2005. The Albstadt/Swabian Jura seismic source zone reviewed through the study of the earthquake of March 22, 2003. Jahresberichte und Mitteilungen des Oberrheinischen Geologischen Vereins 87:391–414.

Tozer B. et al., 2019. Global bathymetry and topography at 15 arc sec: SRTM15+. Earth and Space Science 6(10), 1847–1864.

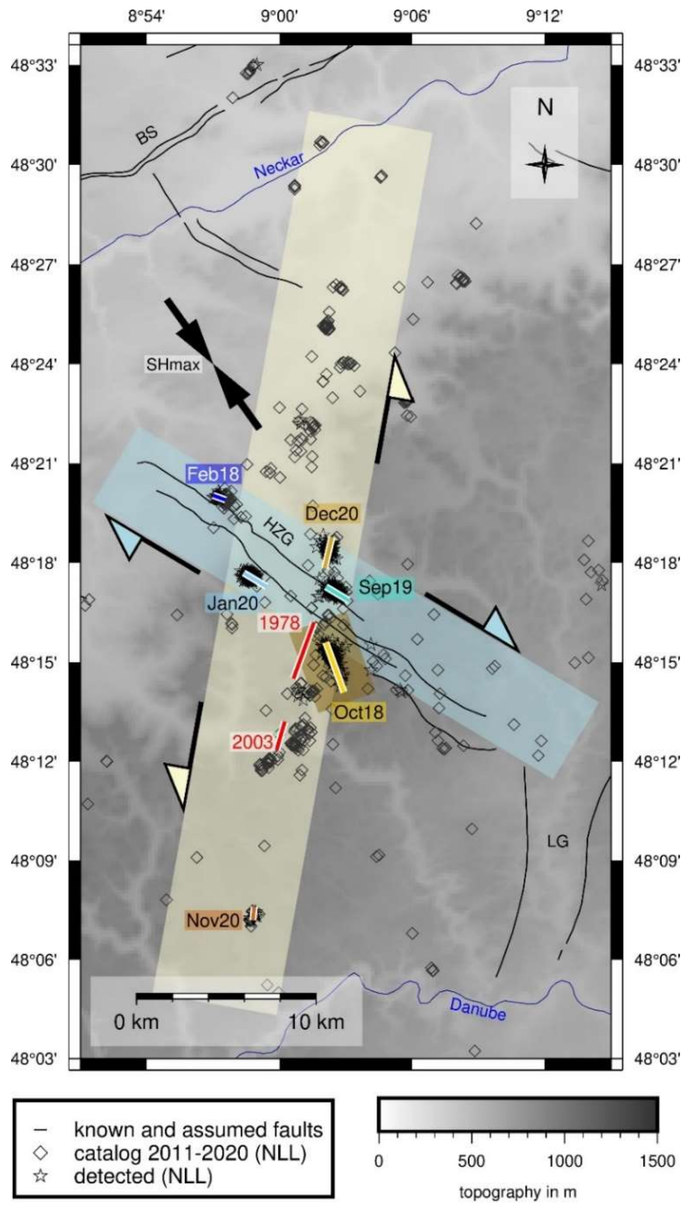

Figure 1: New tectonic model of the western Swabian Alb around Albstadt after Mader et al. (subm.). Colored lines indicate active faults of earthquake sequences. Their lengths are based on HypoDD hypocenter distributions. Red lines show rupture planes of the 1978 and 2003 earthquakes (after Stange and Brüstle, 2005). Blue (NW-SE dextral strike-slip) and yellow (ASZ) shaded areas represent the two active fault zones on the western Swabian Alb. Colored arrows indicate the movement of the strike slip faults. Stars represent NonLinLoc hypocenter locations of detected events (uncertainty < 2 km and at least six phase picks). Best located events (squares) from 2011 to 2018 are from Mader et al (2021b) complemented with new located events in 2019 to 2020 (Mader et al., subm.) using the minimum 1D seismic velocity model ASZmod1 and station corrections in NonLinLoc (Mader et al., 2021b). Black arrows show the direction of the maximum horizontal stress (*SHmax*) after Mader et al. (2021b). Topography is based on SRTM15+ (Tozer et al, 2019).